# PATENT SPECIFICATION

826,198

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

## Improvements in or relating to Oxygen Breathing Masks and Helmets.

We, P. FRANKENSTEIN & SONS (MANCHESTER) LIMITED, a British Company, of Victoria Rubber Works, Newton Heath, Manchester 10, Lancashire, and OTTO WALTER NEUMARK, a British Subject, of 132 Heaton Moor Road, Heaton Moor, Stockport, Cheshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to oxygen breathing masks and helmets intended for wear by persons liable to sudden exposure to ambient atmospheric pressures of less than 140 millimetres of mercury.

It is well known that the absolute pressure of oxygen supplied to the respiratory organs must not fall below the value aforesaid if the subject is to be protected from anoxia even when breathing 100% oxygen.

In order to maintain this safe breathing pressure, oxygen must be supplied to the mask at a relative pressure which exceeds the ambient pressure by an amount equal to the difference between 140 millimetres of mercury and the ambient pressure, the supply being maintained at the appropriate pressure by an automatic oxygen pressure demand regulator of known type.

It is evident, therefore, that pressure-breathing oxygen masks may be called upon to withstand an internal pressure of up to 140 millimetres of mercury, and equally apparent that the force required to hold a pressure-breathing mask to the wearer's face will vary according to the difference between the internal and external pressures and the area of contact between the mask and the face.

In known types of pressure-breathing masks, this force is supplied by mechanical means such as a toggle harness which, being attached to a relatively inelastic flying helmet on the one side and the mask on the other, pulls or presses the latter firmly against the wearer's face, the tightness of the fit necessary to avoid leakage at the edges of the mask being so exceedingly uncomfortable that the mask is invariably loosened when high breathing pressures are not required.

It is, however, an extraordinarily difficult matter to effect such loosening if a transparent or partly transparent, rigid or flexible gas-holding helmet of the so-called "fish-bowl" type (in contrast to a close-fitting pressurized helmet) has been sealed over the head after tensioning of the mask.

Furthermore, known pressure-breathing masks have many protrusions which seriously limit the freedom of head movement when such masks are worn inside helmets of the "fishbowl" type.

The object of the present invention is to provide means whereby the tensile force applied to a pressure-breathing mask for holding the latter to the face is self-regulated by the difference between the breathing pressure and the ambient pressure in such a manner as to maintain a perfect mask/face seal at all times without the necessity for manual adjustment.

A further object of the invention is to provide a mask and helmet assembly or integration which is sufficiently compact to permit free head movement even when it is worn within a gas-holding helmet of the "fishbowl" type and in which the mask tensioning force is automatically relaxed as soon as such helmet is closed and the pressure within it builds up to approximately equal the breathing pressure.

A further object of the invention is to provide a pressure-breathing mask integrated

with a helmet furnished with microphone and earphones so as to form a single item of protective equipment having a minimum weight, which is of great importance when the wearer is subjected to severe accelerations.

According to this invention the improved means for securing a pressure-breathing mask to a flying or crash helmet are characterised in that an inelastic covering applied to the resilient body of the mask has inelastic connections, at least one of which is separable, to further inelastic material confining a bladder located behind the wearer's head and in communication with the pressure-breathing system so that, on increase of breathing pressure, the fit of the mask is automatically tightened by expansion of said bladder to counteract the tendency for the internal pressure within such mask to force the latter away from the wearer's face.

The bladder may be mounted upon the exterior of the helmet, in which case its confining material comprises a fabric covering and/or relatively rigid exoskeleton to which the mask connections are attached.

Alternatively the bladder may be disposed internally of the helmet whose lateral parts are connected to the mask and whose structure serves to restrain the bladder.

In a convenient arrangement, the mask securing means aforesaid are associated with a crash helmet comprising an inner layer of sponge material which has superimposed thereon a protective shell of relatively rigid material.

In the accompanying drawings: —

Figure 1 is a sectional side elevation of a pressure-breathing mask shown in wear and secured in accordance with the present invention,

Figures 2 and 3 are side elevations showing two methods of associating the mask securing means with a normal flying helmet.

Figures 4 to 6 are diagrammatic views illustrating, in appropriate relation to the wearer's head, the several components of an improved crash helmet and mask assembly embodying the present invention,

Figure 7 is a view corresponding to Figures 2 and 3, but showing the assembly illustrated in detail in Figures 4 to 6.

The essential features of the present invention are illustrated diagrammatically in Figure 1, wherein the reference 10 indicates a breathing mask manufactured, by moulding or dipping from natural or synthetic rubber or any suitable plastic, as a hollow member whose inner wall is shaped to fit the contours of part of the wearer's face and has an aperture 11, or pair of apertures, arranged in front of his mouth and nostrils.

This mask 10 has an inelastic fabric covering 12 to restrain its exterior rounded wall, which may be reinforced or replaced, over the same area or in the region of the nose only, by an exoskeletal shell of any suitable stiffening material.

Opposite sides of the mask have connections, indicated at 13, to corresponding parts of a bladder 14 disposed behind the wearer's head and, as illustrated, in direct contact therewith.

The outer wall of this bladder is covered with a non-elastic restraining fabric 15 and/or with a relatively rigid exoskeletal shell corresponding to that just mentioned with reference to the mask 10.

The side connections 13 aforesaid are of an inelastic nature and act upon the fabric restrainers 12, 15 or exoskeletal shells of the mask 10 and bladder 14, so that the pressure to which the latter is inflated determines the tightness of the former's fit upon the face.

Such inflation of the tensioning bladder 14 is effected by means of a tube 16 connecting the same to the mask's oxygen supply or inspiration tube 17, which latter is provided with the usual non-return inlet valve 18 at the same side as the branch tube 16. Alternatively the supply tube 17 may be connected to the bladder 14 and the valve 18 arranged in a branch tube leading to the mask 10.

With either arrangement the outlet from the mask 10 may be placed at the side of the jaw remote from the inlet valve 18, such outlet, or the far end of the exhalation tube (if any), having mounted therein a known form of valve which is spring-loaded to maintain the requisite oxygen pressure within the mask and opens only when such internal pressure is increased by the wearer breathing out. When such a valve is applied to the exhalation tube a simple non-return valve may, in addition, be mounted inside the outlet.

In Figure 2 the tensioning bladder 14 is shown worn externally of a normal flying helmet 19 made of flexible material to which its fabric restrainer 15 is attached by elastic tapes 20, lateral extensions 21 of such restrainer being connected to the equivalent covering 12 of the mask 10.

At least one of such extensions terminates in a triangular metal plate 22 secured thereto by a press-stud and also attachable to any two of a row of press-studs 23 along the adjacent edge of the helmet 19, an adjustable rod connection 24 being arranged between this plate 22 and the mask restrainer 12. It will be appreciated that detachment of the (or each) connector plate 22 from the helmet 19 allows the mask 10 to be swung clear of the face when not in use.

In Figure 3 the tensioning bladder 14, which may be approximately positioned by suitable means relatively to the helmet 19, is disposed internally of the latter, whose own

material thus serves in place of the fabric restrainer 15.

The method of connecting the mask 10 to the sides of the helmet 19 may be as shown in Figure 2, but it is preferred to employ a known form of toggle mechanism in which chains 25 attached to plates 26 at the front edges of the helmet 19 are led to a throw-over lever 27 pivoted upon the restrainer 12 or exoskeleton of the mask 10 and carrying a subsidiary throw-over lever 28 to which the chains 25 are connected. With this known toggle mechanism it is usual for the chains 25 to be connected to a subsidiary throw-over lever 28 mounted upon the main lever 27, upward movement of this lever 28 having the effect of slackening the chains 25 so that the lever 27 can be operated to allow downward movement of the mask 10 clear of the face. However, when such mechanism is associated with a mask-tensioning bladder 14 as aforesaid, it is feasible to dispense with the subsidiary lever 28 and to connect the chains 25 (or cord equivalents) directly to the main lever 27. Furthermore one or each of the chains 25 may have a detachable hook connection at 29 to the adjacent plate 26 which is adjustably positioned upon the helmet 19 by means of the press-studs 23.

In the preferred embodiment shown in Figure 7, the mask-securing means forming the subject of the present invention are associated with a crash helmet 30 which may be integrated with the mask 10 to form a single item of protective equipment, the several components of this helmet/mask assembly being illustrated in Figures 4 to 6 in their respective positions relative to the wearer's head.

The crash helmet 30 includes an inner skull-cap 31 (Figure 4) of open-celled foamed rubber or plastic such as polyurethane with a preferred density in the region of 3 to 8 lbs. per cubic foot and a thickness of the order of 3 to 5 mm.

Superimposed on this flexible skull-cap 31 and engaged with the upturned peripheral lip 32 thereof is a main protective shell 33 (Figure 5) formed of a relatively rigid closed-cell foamed plastic such as polystyrene or polyurethane, having a preferred density of 1 to 5 lbs. per cubic foot and a thickness of the order of 15 to 20 mm. which may be reinforced externally by very thin laminations of resinated glass or asbestos fibre or other suitable material.

Parts of the periphery of the helmet 30 may consist of flexible foamed plastic to assist donning, and ear-pads 34 consisting of laminations of foamed plastics of differing densities may be integrated with the inner skull-cap 31, the protective shell 33 being internally recessed at 35 to clear these.

The breathing mask 10 and its tensioning bladder 14 are illustrated in Figure 6, the exoskeleton 12 of the mask being integrated to the helmet 30 which may have an outer fabric or laminated plastic covering 36, at each side by means of fabric strips 37 which may be elastic or sufficiently slack to permit of the mask being pulled downwards clear of the face, and one of which may incorporate a separable fastening.

The bladder 14 is located, externally of the helmet 30, by means of elastic tapes 20, as in the construction shown in Figure 2, the forward extensions 21 of its outer restraining fabric 15 being passed through loops 38 on the exterior of the helmet and suitably connected to the restrainer 12 or exoskeleton of the mask 10; it being preferred to use a toggle mechanism either of the known form shown in Figure 3 or modified as hereinbefore proposed.

A small microphone is mounted inside the oxygen mask as at 39 and earphones 40 are provided in the built-in ear-pads 34 of the helmet 30, the connecting wires 41 for these being led to the exterior by any suitable route. Provision may also be made on the helmet for the fitting of protective optical filters.

The inspiration tube 17 to the mask 10 (and likewise the exhalation tube, if any) is angled as shown so that the tube or tubes, as the case may be, extend rearwards immediately alongside the jaw, thus keeping the overall dimensions of, and protrusions from, the mask to a minimum whilst permitting free movement of the head.

WHAT WE CLAIM IS:—

1. Means for securing a pressure-breathing mask to a flying or crash helmet, characterised in that an inelastic covering applied to the resilient body of the mask has inelastic connections, at least one of which is separable, to further inelastic material confining a bladder located behind the wearer's head and in communication with the pressure-breathing system so that, on increase of breathing pressure, the fit of the mask is automatically tightened by expansion of said bladder to counteract the tendency for the internal pressure within such mask to force the latter away from the wearer's face.

2. Means according to Claim 1, for securing a pressure-breathing mask to a flying or crash helmet, further characterised in that the tensioning bladder is mounted upon the exterior of the helmet, the confining material comprising a fabric covering and/or relatively rigid exoskeleton to which the mask connections are attached.

3. Means according to Claim 1 for securing a pressure-breathing mask to a flying or crash helmet, further characterised in that the tensioning bladder is disposed

internally of the helmet, whose structure thus provides the restraining material and whose lateral parts are connected to the mask.

4. Mask-securing means according to any one of the preceding claims, further characterised in that the (or each) detachable connection between the mask and the bladder-confining material comprises an adjustable hook fastening.

5. Securing means according to any one of Claims 1 to 3, for a mask provided with known toggle harness normally associated with a helmet, further characterised in that the chains or other flexible tension members of such harness are connected to the bladder-confining material aforesaid.

6. A crash helmet having mask-securing means as claimed in any one of the preceding claims and further characterised in that the mask is integrated with the helmet independently of said securing means.

7. A crash helmet having mask-securing means as claimed in any one of the preceding claims, and comprising an inner layer of sponge material which has superimposed thereon a protective shell of relatively rigid material.

8. Means as claimed in Claim 1 for securing a pressure-breathing mask to a flying or crash helmet, substantially as described with reference to, and as shown in, Figures 2, 3 or 4 to 7 of the accompanying drawings.

For the Applicants,
WILSON, GUNN & ELLIS,
Chartered Patent Agents,
57 Market Street, Manchester 1.

## PROVISIONAL SPECIFICATION.

## Improvements in or relating to Oxygen Breathing Masks and Helmets.

We, P. FRANKENSTEIN & SONS (MANCHESTER) LIMITED, a British Company, of Victoria Rubber Works, Newton Heath, Manchester 10, Lancashire, and OTTO WALTER NEUMARK, a British Subject, of 132 Heaton Moor Road, Heaton Moor, Stockport, Cheshire, do hereby declare this invention to be described in the following statement:—

This invention relates to oxygen breathing masks and integrated helmets intended for wear by personnel who might suddenly be exposed to ambient atmospheric pressures of less than 140 millimetres of mercury.

It is well known that the absolute pressure of oxygen supplied to the respiratory organs must not be less than 140 millimetres of mercury if the subject is to be protected from anoxia even if he is breathing 100% oxygen.

In order to maintain this safe breathing pressure, oxygen must be supplied to the breathing mask at a relative pressure in excess of the ambient pressure equal to the difference between 140 millimetres of mercury and the ambient pressure. The oxygen is supplied at the appropriate pressure by an automatic oxygen pressure demand regulator of a known type.

It is evident, therefore, that pressure-breathing oxygen masks may be required to withstand an internal pressure of up to 140 millimetres of mercury. It is also apparent that the force required to hold a pressure-breathing mask to the wearer's face will vary according to the difference between the internal and the external pressure and the area of contact between the mask and the face.

In pressure-breathing masks of known types, this tensioning force is supplied by mechanical means such as a toggle harness which, being attached to a flying helmet on the one side and the mask on the other, pulls or presses the resilient face mask against the wearer's face to give a pressure-tight fit.

This high compressive fit is extremely uncomfortable and the mask is therefore loosened when high breathing pressures are not required.

It is, however, an extraordinarily difficult matter to effect such loosening if a transparent or partly transparent, rigid or flexible gas-holding helmet of the so-called "fishbowl" type (in contrast to a close-fitting pressurized helmet) is sealed over the head after the mask has been tensioned.

Furthermore, known pressure-breathing masks have many protrusions which seriously limit the freedom of head movement when such masks are worn inside helmets of the "fishbowl" type.

The object of the present invention is to provide an improved construction of pressure-breathing mask and integrated helmet in which the tensile force holding the mask to the face is self-regulated by the difference between the breathing pressure and the ambient pressure in such a manner as to maintain a perfect mask/face seal at all times without the necessity for manual adjustment.

A further object of this invention is to provide a pressure-breathing mask and integrated helmet which is sufficiently compact to permit free head movement even when it is worn within a gas-holding helmet of the "fishbowl" type and in which the mask tensioning force is automatically relaxed as soon as such helmet is closed and the press-

ure within it builds up to approximately equal breathing pressure.

A further object of this invention is to provide a pressure-breathing mask integrated with a helmet furnished with microphone and earphones so as to form a single item of protective equipment having a minimum weight, which is of great importance when the wearer is subjected to severe accelerations.

According to this invention the improved equipment comprises a pressure-breathing face mask communicating with a gas-holding bladder which covers the back and part of the crown of a crash helmet integrated therewith, the mask, bladder and helmet being covered by a close-fitting outer fabric restrainer which, on increase of breathing pressure, is automatically tensioned by the expansion of said bladder so as to counteract the tendency for the internal pressure within the mask to force the latter away from the wearer's face.

Preferably the mask aforesaid is a resilient hollow member manufactured, by moulding or dipping, from rubber, synthetic rubber or any suitable plastic, shaped to fit the contours of part of the wearer's face and provided with a pair of apertures disposed respectively over the mouth and nostrils. The fabric cover restrains the exterior rounded wall of this mask which may be reinforced over the same area or in the region of the nose only by an exoskeletal shell of any suitable stiffening material.

In the latter case the outer restraining fabric need not necessarily cover the shell but may be attached thereto in the region of the hinge of the jaws.

The mask is connected by a gas channel to a bladder designed for application to the back and crown of the crash helmet.

The oxygen supply may be taken directly to the tensioning bladder, in which case a non-return valve may be located in the gas channel leading from the latter to the mask, or it may be taken into the mask alongside one lower jaw bone, preferably on the same side as the channel to the bladder.

The outlet from the mask is in either case arranged at the side of the jaw remote from the channel leading to the bladder, a breathing-pressure compensated valve being mounted either in the actual outlet or at the far end of the exhalation tube. In the latter case a simple non-return valve may, in addition, be mounted inside the outlet.

The exhalation and, if provided, the inspiration tube to the mask is angled so that the tube or tubes, as the case may be, extend rearwards immediately alongside the jaw thus keeping the overall dimensions of, and protrusions from, the mask to a minimum whilst permitting free movement of the head.

To the rear of the exhalation tube's junction with the mask there is a break in the outer restraining fabric (or in the connection of such fabric to an exoskeletal mask shell) to permit of the equipment being put on and taken off, this break being closable by means of a simple fastener.

The crash helmet to be integrated with the mask and tensioning bladder includes an inner layer of open-celled foamed rubber or plastic such as polyurethane with a preferred density in the region of 3 to 8 lbs. per cubic foot and not less than $\frac{1}{8}$ inch thick.

Superimposed on this inner layer is a main protective shell formed of a relatively rigid closed-cell foamed plastic such as polystyrene or isocyanate, having a preferred density of 3 to 5 lbs. per cubic foot and a thickness of preferably not less than $\frac{1}{2}$ inch, which may be reinforced externally by very thin laminations of resinated glass or asbestos fibre or other suitable material.

Parts of the periphery of the helmet may consist of flexible foamed plastic to assist donning and integral ear pads consisting of laminations of foamed plastics of differing densities may be provided.

A small microphone is mounted inside the oxygen mask and earphones are provided in the integral ear pads of the helmet, the connecting wire for these being led to the exterior by any suitable route.

The outer restraining fabric covering of the helmet may be provided with adjustment buckles and may also have cut-outs, both for the purpose of adjusting the mask to a good and comfortable fit during the initial fitting and for aligning the direction of the tensile force which arises during pressure-breathing.

Provision may also be made on the helmet for the fitting of protective optical filters.

For the Applicants,
WILSON, GUNN & ELLIS,
Chartered Patent Agents,
57 Market Street, Manchester 1.

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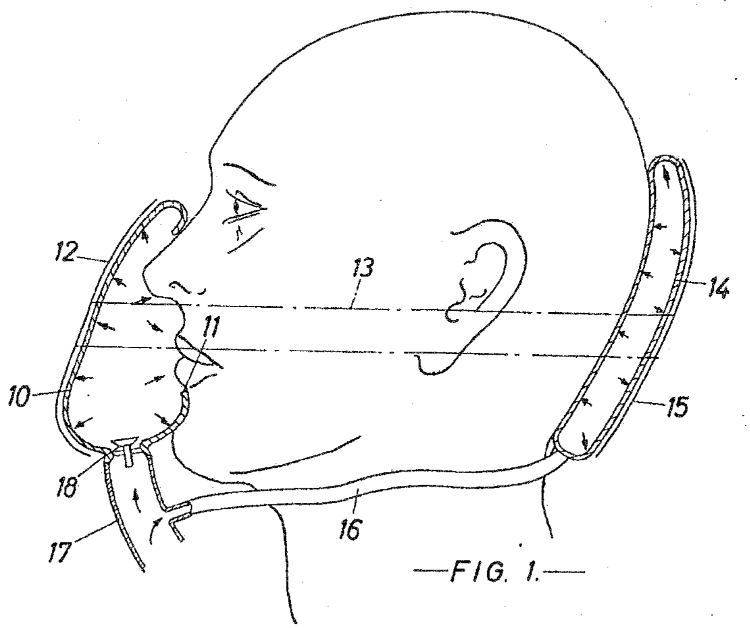
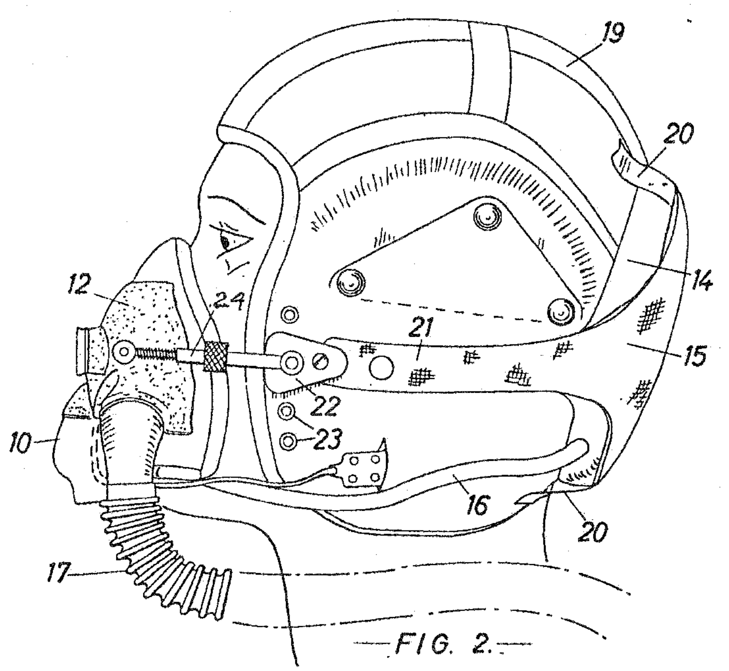
from which copies may be obtained.

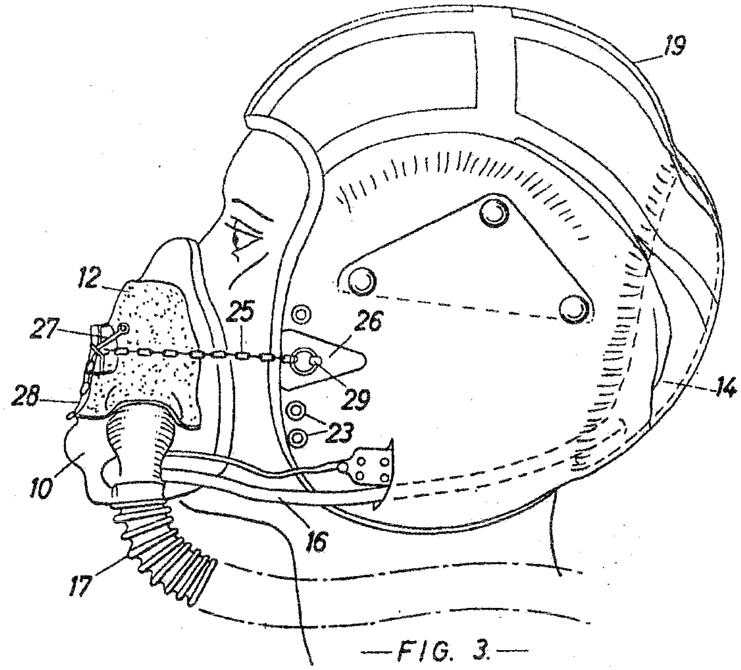
826,198 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEET 1



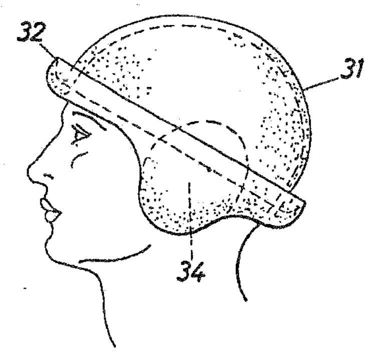

—FIG. 1.—



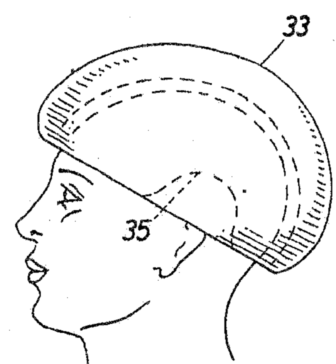

—FIG. 2.—




—FIG. 3.—




—FIG. 4.—




—FIG. 5.—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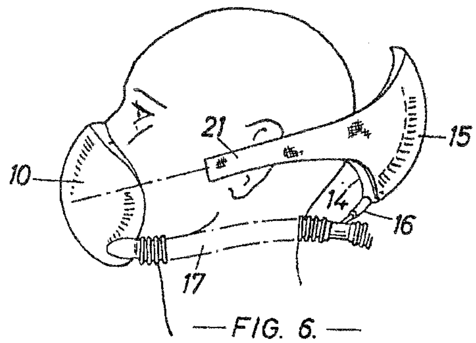
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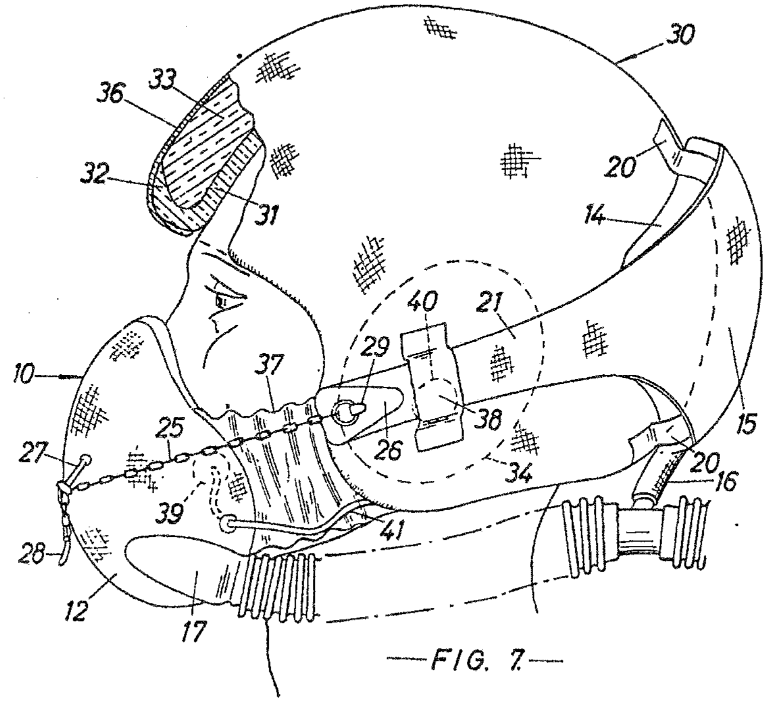
—FIG. 6.—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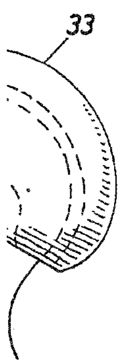
—FIG. 7.—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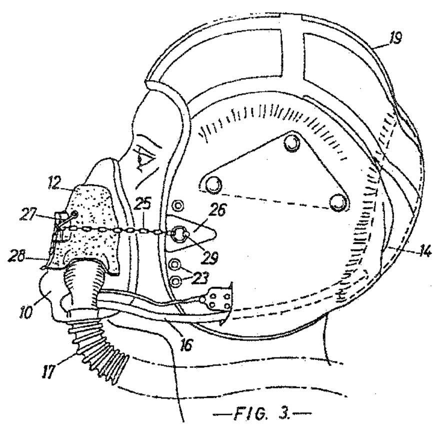
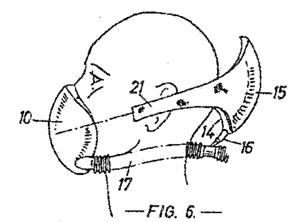
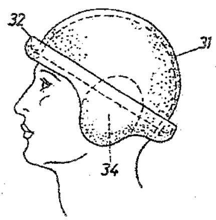
826,198 COMPLETE SPECIFICATION
3 SHEETS
*This drawing is a reproduction of the Original on a reduced scale.*
SHEETS 2 & 3



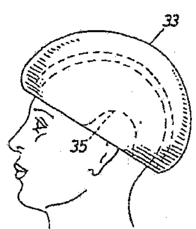

—FIG. 3.—



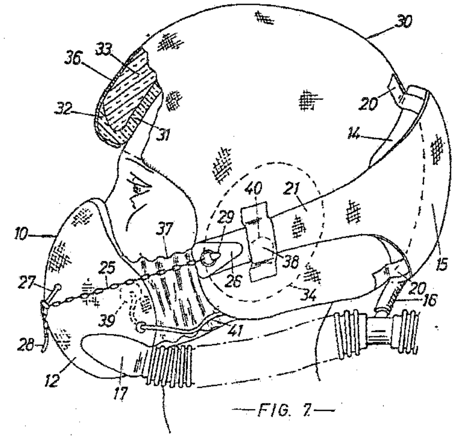

—FIG. 6.—




—FIG. 4.—




—FIG. 5.—




—FIG. 7.—